Assessing the Economic Impacts of the Proposed Ohio EPA Water Rules on the Ohio Economy

April 24, 1997

prepared by

Ohio Environmental Protection Agency
Division of Surface Water
and
Foster Wheeler Environmental Corporation
and
DRI/McGraw-Hill

in support of

Amended and New Rules in OAC Chapters 3745-1, -2, and -33

Summary

The cost of implementing the Water Quality Guidance for the Great Lakes System (GLI) in Ohio has been a subject of considerable debate. To provide definitive data on the cost of the proposed rules, which address the GLI and statewide wasteload allocation and NPDES rules, Ohio EPA contracted with two consulting organizations to perform an in-depth evaluation of the effect of the proposed rules on Ohio's economy. This report outlines the process used by Ohio EPA and its contractors to identify representative wastewater treatment facilities, calculate costs to those facilities, extrapolate facility costs to the whole state, and model the expected impact on the Ohio economy. Although some alternatives evaluated during the cost study would have been quite costly, **the final proposed rule package is projected to have a minor cost implication to Ohio wastewater dischargers and no detrimental impact on the overall Ohio economy.** Potential benefits of implementing the rules are contained in a separate report.

Objectives

The purpose of this study was to evaluate the potential economic impact on Ohio municipal and industrial point source wastewater dischargers due to implementing the GLI for the Lake Erie drainage basin and adopting updated water quality standards, wasteload allocation procedures, and NPDES permitting procedures statewide. Preliminary economic results were used to develop the final proposed rule package to ensure that the necessary rules are implemented in both a cost effective and environmentally protective manner. This report, summarizing the work of Foster Wheeler Environmental Corporation and DRI/McGraw-Hill, presents the estimated costs of the final proposed rule package. A separate report by Hagler Bailly Consulting evaluates the potential benefits of implementing these rules.

Background

Amendments are proposed to be made to seven existing rules in Chapter 3745-1 (Water Quality Standards) and three existing rules in Chapter 3745-33 (Ohio NPDES Permits) of the Ohio Administrative Code. Eight new rules are proposed for Chapter 3745-1; one new rule is proposed for Chapter 3745-33; and eleven new rules are proposed for a new Chapter 3745-2 (Implementation). These rules are being proposed to implement three separate requirements:

- The federally mandated GLI;
- The requirement in ORC Section 6111.12 that all changes to Ohio's wasteload allocation manual be made in rule; and
- The requirement in ORC Section 6111.041 and the Clean Water Act (Section 303) to periodically update water quality standards.

Approach

The Ohio EPA formed an External Advisory Group (EAG) of approximately 25 members (and alternate members) representing municipalities, industries, environmental groups, citizens, and academia to provide input to the Ohio EPA during the development of these rules. Volunteers from the EAG served on an economic subgroup to assist in the development of a work plan to evaluate the economic impacts of the rules.

Developing an interpretation of the regulations that formed the basis of the direct cost estimates to municipalities and industries in Ohio was the first task of the economic analysis. The GLI allows states flexibility in implementing the guidance so that strategies other than end-of-pipe treatment would be encouraged. The key strategies allowed in the GLI are the use of pollution prevention and the development of plans to address all sources of pollutants (both point sources and nonpoint sources, including air deposition, runoff, and contaminated sediments) to develop cost effective and environmentally protective measures to achieve water quality standards.

The EAG economic subgroup identified a number of issues as potential cost drivers. Where more than one implementation option was possible, the subgroup designated different alternatives for evaluation. The regulatory options evaluated in the economic study include:

1. Permit limits based on total recoverable metals water quality criteria versus permit limits based on dissolved metals water quality criteria.
2. End-of-pipe treatment for mercury with no variance provisions versus pollution minimization and a variance from the mercury limit.
3. No intake credits available for noncontact cooling water (NCCW) with possible treatment of NCCW versus use of intake credits and exemption of NCCW from meeting water quality-based effluent limits.
4. Water quality-based effluent limits triggered only when a facility's waste water quality exceeds the calculated wasteload allocation versus triggering such limits when the effluent quality exceeds 75% of the allocation in certain circumstances (decision process is called "determining the reasonable potential").
5. Carcinogenic risk for human health of 1 in 100,000 (10^{-5}) versus 1 in 1,000,000 (10^{-6}).
6. Ohio EPA current whole effluent toxicity (WET) provisions versus Wisconsin WET approach.

The proposed rules have the most potential to affect facilities that hold wastewater discharge permits which contain water quality-based effluent limits. Ohio EPA examined the number of facilities in various industrial categories and POTW size categories (publicly-owned treatment works are typically sewage treatment facilities owned and operated by municipalities and counties). Ohio EPA and Foster Wheeler screened facilities against a set of regulatory and operational criteria and selected facilities representative of the broader population of Ohio dischargers with permits containing water quality-based effluent limits (Table A[1]). A total of 18 dischargers participated in the study (Figure 1). Impacts on indirect industrial dischargers to POTWs were also evaluated.

Ohio EPA staff determined discharge limits and monitoring requirements under the proposed rules for each regulatory option for each facility. The participating facilities and Foster Wheeler evaluated the impact of each regulatory option by comparing the facility's current effluent quality to the proposed discharge limits for each and developing strategies for each scenario in terms of pollution prevention and/or end-of-pipe treatment. The number of dollars it would cost to comply with the proposed rules and each of the regulatory options was then estimated and expressed in terms of dollars spent per year for each pound of pollutant removed. Finally, the compliance cost estimates were used to evaluate and modify the proposed rules where necessary.

With respect to the issues identified by the economic subgroup, the final proposed rule package contains the following provisions:

[1] Figures and Tables follow all report text.

1. Dissolved metals criteria are available and Ohio EPA conducts dissolved metals sampling and develops translators for some dischargers.
2. Relief from the mercury wildlife and human health criteria is available in the form of a special mercury variance for low-level discharges.
3. Intake credits are available until 2007, except for NCCW, which may be exempted from receiving WQBELs in certain circumstances.
4. The risk level for carcinogens is 1 in 100,000 (10^{-5}).
5. Reasonable potential is triggered at 100% (comparing the facility's waste water quality to the allocation), with the comparison at 75% when most of the water body's capacity to assimilate wastes is allocated.
6. The current Ohio EPA WET evaluation approach is used.

A criteria issue (silver) not originally identified as a cost driver showed significant cost impacts during the preliminary analysis and was therefore addressed in the final proposed rules.

Costs of the Proposed Rules

The impact of the final proposed rules on Ohio's economy was estimated by extrapolating the cost data generated for the 18 participating facilities to all other affected facilities in the state. DRI/McGraw-Hill used the aggregated costs in their model of the Ohio economy to predict the overall impact.

Direct Costs for Representative Plants

Tables B and C summarize the costs to the representative plants in the Lake Erie drainage basin and the Ohio River drainage basin, respectively. Each table is further divided into industrial dischargers and publicly owned treatment works. Capital costs noted in the tables include expenditures for equipment, installation, engineering services, special studies, and contingencies. Annual operation and maintenance costs consist of waste management and disposal, utility use, chemicals used in treatment of wastes, sampling, and labor to maintain and operate the treatment facilities. Total annualized costs are based on operations and maintenance costs and the expected life of the capital expenditure items.

In the Lake Erie drainage basin, two industrial facilities (in the organic chemical and steel industries) project significant treatment costs to deal with specific pollutants in their waste streams. One industry (metal finishing) and all the POTW facilities estimate a small net cost savings under the proposed rules. The most significant cost considerations for these facilities are for technical studies (such as dissolved metals translators (DMTs) studies and facility pollutant minimization plans (PMPs)). However, significant savings in effluent monitoring costs are also projected for many sectors.

In the Ohio River basin, most of the industries and all the POTW facilities project a small net cost savings under the proposed rules. Again, the most notable cost considerations are for technical studies, but significant savings in effluent monitoring costs are also projected.

Extrapolation of Direct Costs for the State

The costs of the proposed rule package for each representative facility were extrapolated to the whole population of similar facilities in Ohio based on discharge flow volume. The number of dischargers addressed in each industry or POTW size range is summarized in Table A, which also indicates which of the representative plants was used as the basis for the statewide aggregation in each industry or POTW category. Where no representative facility in a category was available, the representative facility that most closely matched the category type from the perspective of wastewater management was substituted. The costs for each group of similar facilities were then summed to arrive at a statewide cost estimate.

Tables D through G show the projected statewide direct costs of the proposed rule package. In the Lake Erie basin (Table D), a net annual savings of more than $136,000 is estimated for POTWs, while POTWs in the Ohio River basin (Table E) should collectively save more than $294,000 each year. Small study and evaluation costs are expected, but savings in monitoring costs result in a projected net savings to POTWs.

Total costs of about $869,000 are anticipated for industrial dischargers in the Lake Erie basin (Table F). Most of the costs are attributable to the organic chemical industry (both directly and as a surrogate for the rubber manufacturing facilities). Table F also shows the breakdown of estimated costs by type: capital, material, labor, and energy. The proposed rules are not projected to have an economic impact on any indirect industrial dischargers in the Lake Erie basin.

The cumulative net impact of the proposed rules on industrial facilities in the Ohio River basin (Table G) is expected to be about $12,600. Steel mills are expected to be the most impacted, with a total cost of $174,000 projected for the 23 facilities in the basin. Most industrial sector types in the Ohio River basin are projected to have a net cost savings under the proposed rules.

The overall direct cost of the proposed rules for the state of Ohio is projected to be $882,000 for industries, with a net cost savings of $431,000 forecasted for POTWs.

Statewide Indirect Costs

The total benefit of an environmental program is measured not only by counting the amount of pollution removed, but also by analyzing the impact of that program on human health, wildlife, and the value of resources. In the same way, measuring the direct costs of compliance with environmental regulations on industrial facilities, or the cost savings for POTWs, does not provide a complete assessment of their impact on the economy. Indirect costs must also be measured in terms of production, jobs and income.

Compliance costs must be either absorbed by the affected firms in the form of lower profits, or passed on to other firms and consumers as higher prices. Lower profits affect the state economy by reducing the incentive to invest, while higher prices shift the costs to purchasing industries and final consumers. Ultimately, as reduced competitiveness causes layoffs, a cycle of income and expenditure reductions spreads the impact beyond the manufacturing sector.

Two different sets of assumptions were made regarding POTW costs. In the first scenario, the model assumes that savings for POTWs are passed along to consumers and business in the form of lower sewer rates. These lower rates in turn would lower the relative cost of doing business in Ohio, increasing its competitiveness. In addition, lower sewer charges for consumers would raise their discretionary income. Ohio residents could then spend the additional money on local goods and services, providing a boost to the domestic sectors of the state economy. In the second scenario, it is assumed that POTW savings are not passed along to consumers and businesses. There is therefore no reduction in the cost of doing business in Ohio, and no increase in discretionary income for Ohio residents.

DRI used the compliance cost estimates as inputs to the DRI Ohio economic model to capture the indirect economic effects of compliance costs. Foster-Wheeler provided DRI with values for direct compliance costs by industry and production factors: capital, materials, labor, and energy costs. Some materials costs were negative, reflecting reduced monitoring and laboratory costs. Costs for the two basins, Lake Erie and Ohio River, were summed together to get total state costs.

The sectors for which direct compliance costs were estimated were: pulp and paper, power plants, metal finishing and fabrication, steel mills, organic and inorganic chemicals, refineries, and rubber. For all of these sectors, the increased or decreased costs were imposed on the components of the cost equations for the sectors, in the form of indexes.

For the industry impacts, total capital, labor, energy, and material costs were calculated from real shipments data and the four factor shares for each industry. Indexes for increased capital costs in the first year were calculated as the total of baseline capital costs, plus increased capital costs, divided by baseline capital costs. Similar indexes were created for labor, materials, and energy costs for all the impacted sectors. In a number of cases, the new rules would allow lower materials costs for certain sectors. Initial compliance cost ratios were projected over the forecast period as a constant share index, in order to allow for production changes over time. The assumption is that additional compliance costs are proportional to production; if a plant doubled in size, additional compliance costs would also double.

When direct compliance costs are added to the total cost of production for a sector, and Ohio costs rise relative to other areas, the state becomes a more expensive place to do business, and therefore less competitive. Manufacturing production and possibly employment in targeted sectors will fall in Ohio relative to other areas that are not affected by the increased compliance costs.

For POTWs, the cost impact was assumed to fall on residents and businesses. It was assumed in the first scenario that these cost decreases would be passed along as sewer rate decreases to firms and consumers. These business and nonbusiness rate changes would make the cost of doing business, and the cost of living in the state, lower (or higher) than otherwise, in comparison to other states. In this way, the change in costs of POTWs would ripple through the Ohio economy. In addition, lower rates would raise disposable income, as taxpayers would spend the extra money from sewer rate decreases on other goods and services. In these two ways, the direct increased costs of POTWs multiply through the economy.

Scenario 1. The total impact of Ohio rules on the state economy would be relatively small. Total increased costs of $928,000 (excluding negative costs of miscellaneous and federal facilities) imposed on manufacturing sectors would be offset somewhat by negative or decreased costs imposed on POTWs of around $431,000. POTWs would pass along lower costs as lower sewer rates. The total net additional compliance costs of $500,000 should be compared Ohio Gross state product in 1997 forecast at $300 billion. Clearly, these compliance costs are minimal when compared to the Ohio economy overall.

The resulting impact on production, employment, and income is likewise projected to be small. In the years of greatest impact, 2001 to 2002, total employment would increase by 14 jobs. A slight decline in manufacturing jobs due to increased compliance costs would be more than offset by increases in nonmanufacturing employment in trade and services due to lower POTW costs passed through to lower sewer charges, and correspondingly higher real discretionary income.

Increased compliance costs would be concentrated in a few manufacturing sectors: chemicals, refineries, rubber and plastics, and steel mills. Although all of them would experience declines in output, only steel mills would see a slight employment decrease. This is due both to the relatively large compliance cost increase in the sector, and the high sensitivity of steel production to relative costs. Although chemicals would also experience a proportionately large compliance cost increase, its output is less sensitive to relative cost pressures. Rubber and plastics would initially see an output decline due to higher compliance costs. However, its output would eventually increase, due to increased interindustry demand from other sectors, especially electrical equipment and transportation equipment. These latter two sectors would benefit from the lower POTW costs, which would feed through into lower rates and reduced business costs. They would also benefit from the boost to discretionary income enjoyed by consumers due to lower sewer charges.

In a number of sectors, increased compliance costs for capital would be offset by lower costs for operations and maintenance. In other words, purchases of studies or capital equipment would replace current spending for monitoring and lab testing. In several industries, the savings from materials costs would more than offset increased capital costs; pulp and paper, fabricated metals and metal finishing are among them. All of those industries would see increased production, although employment impacts would be small.

Other impacts would be minimal. There would be very little change in wage rates, the unemployment rate, the Ohio consumer price index (CPI), and population.

Scenario 2. The second scenario differs from the first in only one respect; lower POTW costs are **not** assumed to be passed on in lower sewer rates to businesses and consumers. All of the benefit is assumed to go to the sewer authority, or to the local government. Savings from lower POTW costs are assumed to be spent on other sewer authority or government projects.

In the second scenario, the maximum employment change would be a loss of three jobs, one in primary metals, and two in nonmanufacturing. Production declines in all affected manufacturing sectors would be slightly greater, as there is no offset to the their increased compliance costs. Other impacts would again be minimal, as in the first case.

Other Cost Considerations

The interactive EAG process used to develop the proposed rules has produced rules that are both protective of the environment and cost effective to implement. Evaluating the compliance costs of specific rule provisions, and quantifying the amount of pollutant reduction, has allowed Ohio EPA to characterize the impact of the most probable results. This reduced the regulatory uncertainty for both the Ohio EPA and the regulated community.

The direct compliance costs associated with all options listed in the "Approach" section of this report were evaluated. These options identified four key implementation issues that could have led to very significant compliance costs with little demonstrated reduction on pollutant loadings. Of the four issues, two account for the majority of the added costs: mercury requirements and intake credit phase out and the implication relative to non-contact cooling water streams. Two others are significant but less important: limits based on total recoverable metals criteria (as opposed to dissolved) and ambient water quality criteria for silver. The cost and technical factors associated with these four alternative regulatory options are reviewed briefly following the discussion of the possible economic impact the four options would have had if they had been included in the proposed rules.

An estimate of the statewide direct compliance costs associated with this collection of issues is contrasted in Table H with the cost of the proposed rules. The proposed rules will result in considerable "savings" for Ohio dischargers as compared with the four alternative regulatory options: about $50 million per year (cumulative) for industry in each basin, approximately $12 million per year for POTWs in the Ohio River basin, and over $1.2 billion per year for POTWs in the Lake Erie basin.

The impact of the four alternative regulatory options on the Ohio economy was also analyzed using the DRI model. In this case, compliance costs for manufacturing industries were much higher. In addition, POTW costs were very significantly positive, due to the need for much more expensive water treatments. Whereas the rule case increased total costs by $500,000, the alternative regulatory options scenario would increase costs by $1.3 billion: $79 million on manufacturing firms, and $1.2 billion on POTWs. In this case, real output would decrease in all impact sectors, and also all other manufacturing sectors except nonelectrical machinery. A maximum total employment decline of 47,000 jobs (-0.8%) would be reached in 2001. Manufacturing jobs would fall by 13,000 (-1.21%), and nonmanufacturing jobs would fall by 34,000 (-0.74%). The largest percentage employment declines would be suffered by the rubber and plastic industry (-1.14%), and metal fabrication and finishing (-2.24%). Total state and local government taxes would increase by $1.3 billion, or 3.7%, to pay for the increased POTW costs. Total personal income would fall by 0.8%, and real discretionary income would fall by 1.2%.

Mercury Requirements

The water quality criteria for the protection of wildlife associated with the GLI results in permit limits for mercury in the range of 14 parts per trillion[2] (ppt) to 1.3 ppt, depending on the applicability and nature of a mixing zone in the receiving water body. These concentrations are lower than the current Ohio EPA Method Detection Level (MDL) of 200 ppt and the Ohio EPA Practical Quantification Limit (PQL) of 1000 ppt. Consequently, there is a great deal of uncertainty regarding the actual level of mercury in Ohio water bodies and waste water discharges. Many dischargers who currently monitor for mercury obtain results showing "non-detect" at the MDL or PQL associated with their respective analytical methods. Newer "clean" analytical sampling and analytical methods currently under development and testing by the U.S. EPA are promising a lower MDL of approximately 0.2 ppt. Available data analyzed using these new techniques shows that water bodies and waste water discharges generally exceed 1.3 ppt. At the present time, however, it is not generally practical to measure and determine if a discharger's effluent is or is not in compliance with permit limits in the range of 14 to 1.3 ppt.

Similarly, the amount of reduction in loading necessary to achieve compliance with a mercury limit at these very low levels cannot be precisely specified due to these current analytical limitations. Reducing the concentration of mercury in an effluent stream from the current MDL of 200 ppt to an allowable limit of 1.3 ppt would require a 99.35% reduction in loading. If actual mercury concentrations were much less than the current "non-detect" levels, proportionately lower percentage reductions would be needed for compliance. The necessary percentage reduction in mercury loading is important to determining how the reductions could possibly be achieved if effluent treatment is required.

[2] 1 ppt = 1 nanogram per liter (ng/l)

Different water treatment technologies can provide different characteristic reductions in mercury levels because of the chemical or physical processes on which they are based. The level of reduction possible also depends on the initial mercury concentration in the influent stream to be treated. For influent concentrations up to 100,000 ppt, four primary treatment processes are typically effective in reducing mercury levels: biologically activated sludge, chemical precipitation, ion exchange, and reverse osmosis. The systems are estimated to have annualized costs for typical industrial or POTW flows on the order of $10 to $100 million per pound of mercury removed. Details on the cost and effectiveness of each process are included in the attachment to this report.

<u>Intake Credits and Non-contact Cooling Water</u>

The more stringent ambient water quality standards associated with the GLI are, for some pollutants, very near or lower than current background levels of these same constituents in Ohio's waters. This situation creates uncertainty with industrial dischargers regarding the possible need to treat water drawn into a facility from a water body whose background quality does not currently comply with the new ambient water quality standards when that water is used in a manner that would not change its chemical characteristics prior to discharge. The implications of this uncertainty is further magnified by the phasing out of intake credits by 2007 in the GLI. Under the GLI, other mechanisms for addressing the situations currently associated with the issue of intake credits are likely to be implemented by the phase out date (e.g., total maximum daily loads (TMDLs)).

One type of discharge stream most significantly affected by this situation is non-contact cooling water (NCCW). NCCW streams associated with Ohio dischargers range in flows from 0.01 to over 1000 MGD. Large NCCW streams are generally associated with power plants and steel mills, but other industries also can have smaller NCCW streams and outfalls. A requirement to treat a sizable NCCW stream to remove a small amount of a pollutant that was present in the intake flow and was not added by the facility would result in very significant costs to those facilities with typically little reduced pollutant loading benefit, especially for those with one or more large NCCW streams.

Current federal and Ohio regulations do not contain provisions to grant intake credits for water quality-based limits. However, current Ohio EPA policy allows for consideration of background water quality in the development of wasteload allocations and permit limits when background concentrations exceed ambient water quality criteria. Typically, Ohio EPA would require sufficient sampling and a demonstration of "no net addition" of the pollutant whose concentration is exceeded in the intake water body.

Under the proposed rules, intake credits will be available statewide until 2007, as specified in the GLI. However, provisions are contained in the proposed rule which would allow for NCCW streams to be exempt from receiving WQBELs under certain prescribed circumstances that demonstrate the "no net addition" situation.

<u>Dissolved Metals</u>

Expressing water quality criteria for metals as the dissolved form has been recommended by U.S. EPA since 1993. Using the dissolved portion is perceived by the regulated community as a benefit because higher WQBELs may result, but the environmental community is concerned about accumulation of metals in aquatic organisms and a buildup of metals in sediments.

Effectively using the dissolved criteria to generate permit limits for point sources requires that the relationship between the total recoverable and dissolved components (known as a translator) be defined in the waterbody receiving the wastewater discharge. A translator is affected by many waterbody characteristics including flow, solids concentration, conductivity, and pH. Thus, to apply dissolved criteria while protecting Ohio waterbodies requires that substantial regional and location-specific data be collected in Ohio to define the translator relationship.

Ohio EPA has devised a strategy to make dissolved criteria available for use in Ohio while providing safeguards for waterbodies:

1. Ohio EPA will move forward with a sampling plan to determine translators for specific water bodies and make translators available to a large number of dischargers. Although not every discharge can be included, the Agency will examine the dischargers most affected by the proposed rules and focus its translator development on those dischargers.
2. Ohio EPA will grant dischargers who cannot comply with lower total metals permit limits a compliance schedule. The schedule would allow time for translator studies to be performed that may justify higher limits based on dissolved metals criteria.
3. Ohio EPA will allow dischargers who can comply with lower total metals permit limits up to two years to conduct translator studies to justify limits up to their current permit loading level without the revised limits being disallowed for antibacksliding or antidegradation reasons. This is a transitional accommodation that will expire in five years.
4. Ohio EPA will use the existing biological criteria in the water quality standards rules (OAC 3745-1) to ensure that designated uses are protected.

Silver Criteria

Silver was evaluated in the direct cost impact study using permit limits based on draft U.S. EPA aquatic life water quality criteria published in the Federal Register for comment on May 14, 1990 (55 FR 1986). Those criteria were never finalized. On June 30, 1992 Tudor Davies, Director of the U.S. EPA Office of Science and Technology, indicated in a letter to U.S. EPA Regional Water Management Division Directors that, based on public comment, U.S. EPA has decided to do additional research on silver before finalizing the criteria.

The draft silver criteria were used in the direct cost impact study because those criteria represent a worst case scenario and criteria calculated using the GLI aquatic life methodology would likely result in criteria no more stringent than those draft criteria. The use of those criteria resulted in high projected wastewater treatment costs for two POTWs (Lorain and Lima) and one industry (USS/Kobe) in the Lake Erie basin and one POTW (Springfield) and one industry (Navistar) in the Ohio River basin.

Ohio EPA had not intended to propose numeric silver criteria in rule. Rather, the narrative methodologies in the proposed rule would be used to calculate criteria or Tier II values for silver when needed. Based on the results of the direct cost impact study, Ohio EPA is now proposing to retain its current silver criteria in rule until information becomes available to calculate alternate criteria. By retaining the current silver criteria, treatment costs for silver are not significantly increased under the proposed rules.

Table A. Number of Ohio Facilities with Wastewater Permits Containing Water Quality-Based Effluent Limits (6 pages)

Facility Type	No. of Facilities (No. of WLAs) [A]	Representative Facility
Pulp and paper mills typically 'A' in Ohio permit number *Pulp and paper mills manufacture pulp, which is derived from wood fibers. The pulp is then converted into products such as paper, cardboard, and boxes.*	LEB: 1 (1) ORB: 11 (10)	Mead Paper, discharging to Paint Creek near Chillicothe in the Scioto River basin (ORB)
Power plants typically 'B' in Ohio permit number *Power plants provide the generation, transmission, and/or distribution of electricity to the general public; may also provide distribution of natural gas as an energy source.*	LEB: 7 (6) ORB: 18 (14)	Cleveland Electric Illuminating (CEI) - Eastlake Facility, discharging to Lake Erie east of Cleveland (LEB) AEP/Buckeye Power Cardinal Operating Plant, discharging to the Ohio River and a small tributary south of Steubenville (ORB)
Metal finishing typically 'C' in Ohio permit number *Metal finishers may produce or purchase raw metal products, which are then colored, electroplated, coated, or treated in some way to create a final product which can be distributed to the consumer.*	LEB: 7 (7) ORB: 19 (15)	Argo-Tech, discharging to Lake Erie east of Cleveland (LEB) Navistar, discharging to an unnamed tributary of Moore Run, which flows into the Mad River north of Springfield, in the Great Miami River basin (ORB)
Steel mills typically 'D' in Ohio permit number *Steel mills convert raw material/ore into usable steel. The steel is formed into basic shapes such as plates, strips, rods, or sheets.*	LEB: 2 (2) ORB: 28 (24)	USS/Kobe, discharging to the Black River north of Elyria (LEB) Wheeling-Pittsburgh Steel - South Plant, discharging to the Ohio River south of Steubenville (ORB)
Inorganic chemical plant typically 'E' in Ohio permit number *Inorganic chemical plants produce basic compounds or use chemical processes in their operations. Chemicals produced include synthetic fibers, pigments, drugs, paints, and fertilizers. Inorganic chemicals used in daily operations may be salts, acids, or alkalies (bases).*	LEB: 8 (7) ORB: 4 (2)	Dischargers in this category often receive water-quality based effluent limits (WQBELs) and will be affected by this rulemaking. However, dischargers in the category are quite varied, and no facility would be representative of the others. Given the scope of the economic study, no facility in this category was included. The category "metal fabrication" should most closely approximate costs for this category.

Table A. Number of Ohio Facilities with Wastewater Permits Containing Water Quality-Based Effluent Limits (6 pages)

Facility Type	No. of Facilities (No. of WLAs) [A]	Representative Facility
Organic chemical plant typically 'F' in Ohio permit number *Organic chemical plants primarily manufacture organic chemicals. One such group might be solvents like ether, acetone, and ethyl alcohol. Other compounds could be plastics, perfumes, flavorings, and organic acids.*	LEB: 4 (3) ORB: 14 (12)	Arcadian (BP Chemicals), discharging to the Ottawa River near Lima, in the Maumee River basin (LEB) Shell Chemical, discharging to the Ohio River downstream of Marietta (ORB)
Refinery/oil producer typically 'G' in Ohio permit number *Refineries obtain raw petroleum (crude oil) and convert them into useful and usable products. Depending on the amount of refining, numerous products can be made. Such products are gasoline, kerosene, oils, greases, asphalt, and countless others.*	LEB: 3 (3) ORB: 1 (1)	BP Oil Company, discharging to Maumee Bay in Lake Erie near Toledo (LEB)
Food processor typically 'H' in Ohio permit number *The food processing industry is primarily concerned with the manufacturing or processing of foods and beverages for human consumption. Other related areas may include preparing feed for animals and the production of manufactured ice.*	-	Dischargers in this category typically receive limits for oxygen-demanding parameters, which are not proposed to change from current practice in this rulemaking.
Stormwater typically 'I' in Ohio permit number *Facilities that deal with stormwater collect and/or reroute excessive water that is produced when a storm event occurs.*	-	Most dischargers in this category do not receive WQBELs; this rule package should have de minimus effects. No representative of this category is necessary.
Sand and gravel producer typically 'J' in Ohio permit number *These facilities are where the mining of sand and gravel takes place. At the pit, the sand and gravel is dredged, screened, and washed.*	-	Dischargers in this category typically do not receive WQBELs; this rule package should have de minimus effects. No representative of this category is necessary.

Table A. Number of Ohio Facilities with Wastewater Permits Containing Water Quality-Based Effluent Limits (6 pages)

Facility Type	No. of Facilities (No. of WLAs) [A]	Representative Facility
Tannery/rendering plant typically 'K' in Ohio permit number *These plants obtain nonedible portions of slaughtered livestock and create useful products such as leather, fish and animal meal, fish oil, and greases.*	-	Dischargers in this category typically do not receive WQBELs; this rule package should have de minimus effects. No representative of this category is necessary.
Coal washer typically 'L' in Ohio permit number *Coal washers are usually on-site at a strip mine. Coal cleaning involves refining the coal and reducing impurities in the rock so that it may be more energy efficient when burned.*	-	Dischargers in this category do not typically receive WQBELs; this rule package should have de minimus effects. No representative of this category is necessary.
Industrial sewage typically 'M' in Ohio permit number *Industrial sewage is the domestic wastewater produced by industrial facilities. These facilities may or may not have on-site treatment processes prior to disposal.*	-	Most dischargers in this category do not receive WQBELs; this rule package should have de minimus effects. No representative of this category is necessary.
Miscellaneous typically 'N' in Ohio permit number *This category includes non-contact cooling water, storm water, boiler blowdown, petroleum bulk storage terminals, ground water remediation and landfill storm water runoff.*	LEB: 2 (0) ORB: 4 (3)	Most of the facilities in this category were reassigned to categories that reflected their process waste. Those that remain are involved in the manufacture of glass products. The category "metal fabrication" would most closely approximate the costs associated with the rulemaking for these facilities.
Federal facilities typically 'O' in Ohio permit number *Federal facilities include government owned and operated businesses. In Ohio, federal facilities include laboratories, research centers, and weapons manufacturing facilities.*	LEB: 1 (1) ORB: 4 (3)	Dischargers in this category usually receive WQBELs and will be affected by this rulemaking. Given the scope of the economic study, no facility in this category was included. The costs associated with the category "metal finishing" should be used to approximate costs for this category.
Acid mine drainage typically 'P' in Ohio permit number *Acid mine drainage is typically derived from strip mining of coal. Runoff from strip mines produces highly acidic water when reacted with minerals found with the coal.*	-	Most dischargers in this category do not receive WQBELs; this rule package should have de minimus effects. No representative of this category is necessary.

Table A. Number of Ohio Facilities with Wastewater Permits Containing Water Quality-Based Effluent Limits (6 pages)

Facility Type	No. of Facilities (No. of WLAs) [A]	Representative Facility
Plastic fabrication typically 'Q' in Ohio permit number *Plastic fabricators manufacture numerous plastic products, ranging from films and plastic sheets to lamination, bottles, hoses, and bubble formed packaging.*	LEB: 0 (0) ORB: 3 (2)	Most dischargers in this category do not receive WQBELs; this rule package should have de minimus effects. No representative of this category is necessary.
Rubber fabrication typically 'R' in Ohio permit number *Rubber fabricators produce many rubber products, such as tires, inner tubes, garden hoses, belts, and footwear (soles).*	LEB: 6 (2) ORB: 8 (2)	These dischargers sometimes receive WQBELs and could be affected by this rulemaking. Dischargers in the category are quite varied, and one facility would not be representative of the others. Given the scope of the economic study, no facility in this category was included. Depending on the facility, the costs associated with the categories "metal fabrication", "organic chemical plant", or "plastic fabrication" should be used to approximate costs for this category.
Metal fabrication typically 'S' in Ohio permit number *Metal fabricators shape and create specific metal products, which may or may not be derived from iron. Fabricated products include metal cans, hand tools, cutlery, hardware, screws, bolts, and washers.*	LEB: 3 (3) ORB: 12 (8)	Burnham Boiler Company, discharging to the Licking River near Zanesville (ORB)
Railroad facilities typically 'T' in Ohio permit number *Railroads generally provide long distance transportation of goods and/or passengers. A complete railroad system includes terminals, switch yards, and the line on which the railway operates.*	-	Dischargers in this category typically do not receive WQBELs; this rule package should have de minimus effects. No representative of this category is necessary.
No treatment typically 'U' in Ohio permit number	-	Dischargers in this category typically do not receive WQBELs; this rule package should have de minimus effects. No representative of this category is necessary.

Table A. Number of Ohio Facilities with Wastewater Permits Containing Water Quality-Based Effluent Limits (6 pages)

Facility Type	No. of Facilities (No. of WLAs) ^A^	Representative Facility
Drinking water purification plants typically 'V' through 'Z' in Ohio permit number	-	Dischargers in this category typically do not receive WQBELs; this rule package should have de minimus effects. No representative of this category is necessary.
Public WWTP, greater than 50 MGD typically 'F' or 'M' in Ohio permit number *These facilities are designed to accept and treat sewage from households and/or businesses.*	LEB: 5 (4) ORB: 4 (4)	Dischargers in this category receive WQBELs and will be affected by this rulemaking. Given the scope of the economic study, no facility in this category was included. The costs associated with the category "Public WWTP, 10 to 50 MGD" should be used to approximate costs for this category.
Public WWTP, 10 to 50 MGD typically 'E' or 'L' in Ohio permit number *These facilities are designed to accept and treat sewage from households and/or businesses.*	LEB: 13 (13) ORB: 15 (15)	Lima WWTP, discharging to the Ottawa River (LEB) Lorain East WWTP, discharging to Lake Erie (LEB) Springfield WWTP, discharging to the Mad River (ORB)
Public WWTP, 1 to 10 MGD typically 'D' or 'K' in Ohio permit number *These facilities are designed to accept and treat sewage from households and/or businesses.*	LEB: 58 (55) ORB: 114 (106)	Allen Co. Shawnee #2 WWTP, discharging to the Ottawa River near Lima (LEB) Bucyrus WWTP, discharging to the Sandusky River (LEB) Galion WWTP, discharging to the Olentangy River (ORB) Gallipolis WWTP, discharging to the Ohio River (ORB)
Public WWTP, 0.5 to 1 MGD typically 'C' or 'J' in Ohio permit number *These facilities are designed to accept and treat sewage from households and/or businesses.*	LEB: 20 (14) ORB: 63 (44)	Dischargers in this category typically receive limits only for oxygen-demanding parameters, which are not proposed to change from current practice in this rulemaking. A few (category have WQBELs because they have indirect dischargers and an approved pretreatment program.

Table A. Number of Ohio Facilities with Wastewater Permits Containing Water Quality-Based Effluent Limits (6 pages)

Facility Type	No. of Facilities (No. of WLAs) [A]	Representative Facility
Public WWTP, 0.1 to 0.5 MGD typically 'B' or 'H' in Ohio permit number *These facilities are designed to accept and treat sewage from households and/or businesses.*	LEB: 78 (23) ORB: 166 (86)	Dischargers in this category typically receive limits only for oxygen-demanding parameters, which are not proposed to change from current practice in this rulemaking.
Public WWTP, less than 0.1 MGD typically 'A' or 'G' in Ohio permit number *These facilities are designed to accept and treat sewage from households and/or businesses.*	LEB: 137 (13) ORB: 182 (27)	Dischargers in this category typically receive limits only for oxygen-demanding parameters, which are not proposed to change from current practice in this rulemaking.
Other public typically 'N' through 'Z' in Ohio permit number *Represents mostly Federal and state facilities, regional authorities, PUCO facilities, subdivisions and apartment complexes, semi-public facilities, schools and hospitals, mobile home parks, and miscellaneous.*	-	Dischargers in this category typically do not receive WQBELs; this rule package should have de minimus effects. No representative of this category is necessary.

[A] Indicates the approximate number of facilities in category with an active process discharge in the Lake Erie drainage basin (LEB) or the Ohio River drainage basin (ORB). Facilities with a permit number designation that did not truly indicate existing plant processes were included in the proper facility type. Number of WLAs indicates approximate number of these facilities for which a wasteload allocation (resulting in water quality-based permit limits) has been conducted.

0004077

Figure 1. Representative Facilities

Lake Erie Drainage Basin

Facility	Category
Arcadian Ohio, L.P.	Organic chemical
CEI, Eastlake Plant	Power
Argo-Tech	Metal finishing
USS /Kobe Steel	Steel
BP Oil, Toledo	Oil refining
Lima WWTP	Large POTWs
Lorain WWTP	Large POTWs
Allen Co. Shawnee #2 WWTP	Small POTWs
Bucyrus WWTP	Small POTWs

Ohio River Drainage Basin

Facility	Category
Mead Paper	Pulp & paper
AEP, Cardinal Plant	Power
Wheeling-Pittsburgh Steel	Steel
Navistar International	Metal finishing
Burnham Boiler	Metal fabrication
Shell Chemical	Organic chemical
Springfield WWTP	Large POTWs
Galion WWTP	Small POTWs
Gallipolis WWTP	Small POTWs

Table B. Summary of Projected Costs of Proposed Rules for Representative Facilities in the Lake Erie Drainage Basin

Facility	Facility Type	Total Constructed Capital Cost ($)	Total Annual O&M Cost ($/Year)	Total Annualized Cost ($/Year)	Cost Drivers
INDUSTRIAL DIRECTS					
BP Chemical - Arcadian	Organic Chemicals	$3,374,250	$286,331	$511,281	Cn (Free), DMT Study, PMP, Net reduced monitoring
CEI - Eastlake	Power Plant	$5,000	$384	$717	DMT Study, Net increased monitoring
BP Oil, Toledo Refinery	Refinery / Oil Producer	$10,000	$7,398	$8,065	DMT Study, PMP, Net increased monitoring
Argo - Tech	Metal Finishing	$5,000	($5,304)	($4,971)	DMT Study, Net reduced monitoring
USS / Kobe	Steel Mill	$251,000	$30,700	$47,433	Se, DMT Study, PMP, Net increased monitoring
POTWs					
Lima WWTP					
Direct	POTW	$10,000	($6,140)	($5,473)	DMT Study, PMP, Net reduced monitoring
Indirects	None Affected	$0	$0	$0	None
Lorain WWTP					
Direct	POTW	$10,000	($10,442)	($9,775)	DMT Study, PMP, Net reduced monitoring
Indirects	None Affected	$0	$0	$0	None
Allen Co. Shawnee #2 WWTP					
Direct	POTW	$0	($234)	($234)	Net reduced monitoring
Indirects	None Affected	$0	$0	$0	None
Bucyrus WWTP					
Direct	POTW	$10,000	$(728)	($61)	DMT Study, PMP, Net reduced monitoring
Indirects	None Affected	$0	$0	$0	None

(net savings/negative costs relative to current circumstances shown in parenthesis)

Table C. Summary of Projected Costs of Proposed Rules for Representative Facilities in the Ohio River Drainage Basin

Facility	Facility Type	Total Constructed Capital Cost ($)	Total Annual O&M Cost ($/Year)	Total Annualized Cost ($/Year)	Cost Drivers
INDUSTRIAL DIRECTS					
Mead Paper	Pulp and Paper	$5,000	($1,580)	($1,247)	DMT Study, Net reduced monitoring
AEP-Cardinal	Power Plant	$5,000	($2,392)	($2,059)	DMT Study, Net reduced monitoring
Wheeling-Pitt Steel (South)	Steel Mill	$10,000	$6,924	$7,591	DMT Study, Background Study, Net increased monitoring
Navistar International	Metal Finishing	$5,000	($4,784)	($4,451)	DMT Study, Net reduced monitoring
Burnham Boiler	Inorganic Chemicals	$0	($5,604)	($5,604)	Net reduced monitoring
Shell Chemical	Organic Chemicals	$0	$2,448	$2,448	Net increased monitoring
POTWs					
Springfield WWTP					
Direct	POTW	$5,000	($1,510)	($1,177)	DMT Study, Net reduced monitoring
Indirects	None Affected	$0	$0	$0	None
Galion WWTP					
Direct	POTW	$5,000	($4,428)	($4,095)	DMT Study, Net reduced monitoring
Indirects	None Affected	$0	$0	$0	None
Gallipolis WWTP					
Direct	POTW	$5,000	($1,176)	($834)	DMT Study, Net reduced monitoring
Indirects	None Affected	$0	$0	$0	None

(net savings/negative costs relative to current circumstances shown in parenthesis)

Table D. Aggregated Projected Costs of Proposed Rules for Lake Erie Basin POTW Facilities

Sector	WLA Facility Type (#)	Total Annualized Cost ($/Year)	Capital Cost ($/Year)	Material Cost ($/Year)	Labor Cost ($/Year)	Energy Cost ($/Year)
POTWs > 50 MGD	Direct (4)	($30,497)	$2,667	($33,164)	$0	$0
POTWs 10 to 50 MGD	Direct (13)	($96,965)	$8,667	($105,632)	$0	$0
POTWs 1 to 10 MGD	Direct (60)	($8,860)	$20,000	($28,860)	$0	$0
TOTALS	77 Facilities	($136,323)	$31,333	($167,656)	$0	$0

(net savings/negative costs relative to current circumstances shown in parenthesis)

Table E. Aggregated Projected Costs of Proposed Rules for Ohio River Basin POTW Facilities

Sector	WLA Facility Type (#)	Total Annualized Cost ($/Year)	Capital Cost ($/Year)	Material Cost ($/Year)	Labor Cost ($/Year)	Energy Cost ($/Year)
POTWs > 50 MGD	Direct (4)	($4,707)	$1,333	($6,040)	$0	$0
POTWs 10 to 50 MGD	Direct (15)	($17,560)	$5,000	($22,650)	$0	$0
POTWs 1 to 10 MGD	Direct (107)	($272,277)	$35,667	($307,944)	$0	$0
TOTALS	126 Facilities	($294,634)	$42,000	($336,634)	$0	$0

(net savings/negative costs relative to current circumstances shown in parenthesis)

Table F. Aggregated Projected Costs of Proposed Rules for Lake Erie Basin Industrial Facilities

Sector	WLA Facility Type (#)	Total Annualized Cost ($/Year)	Capital Cost ($/Year)	Material Cost ($/Year)	Labor Cost ($/Year)	Energy Cost ($/Year)
Pulp and Paper	Direct (1)	($1,247)	$333	($1,580)	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Power Plants	Direct (6)	$4,304	$2,000	$2,304	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Metal Finishing	Direct (7)	($34,795)	$2,333	($37,128)	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Steel Mills	Direct (2)	$59,667	$19,267	$25,400	$11,000	$4,000
	Indirect (0)	$0	$0	$0	$0	$0
Inorganic Chemical Plants	Direct (7)	($16,812)	$0	($16,812)	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Organic Chemical Plants	Direct (3)	$792,913	$349,166	$129,497	$235,687	$78,562
	Indirect (0)	$0	$0	$0	$0	$0
Refinery / Oil Producer	Direct (3)	$24,194	$2,000	$22,194	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Miscellaneous	Direct (2)	($11,208)	$0	($11,208)	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Federal Facilities	Direct (0)	$0	$0	$0	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Rubber Fabrication	Direct (2)	$57,903	$25,874	$8,743	$17,465	$5,822
	Indirect (0)	$0	$0	$0	$0	$0
Metal Fabrication	Direct (1)	($5,604)	$0	($5,604)	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Hospitals	Direct (0)	$0	$0	$0	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Photographic Facilities	Direct (0)	$0	$0	$0	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
TOTALS	34 Facilities (34 Direct, 0 Indirect)	$869,315	**$400,973**	**$115,806**	**$264,152**	**$88,384**

(net savings/negative costs relative to current circumstances shown in parenthesis)

0004082

Table G. Aggregated Projected Costs of Proposed Rules for Ohio River Basin Industrial Facilities

Sector	WLA Facility Type (#)	Total Annualized Cost ($/Year)	Capital Cost ($/Year)	Material Cost ($/Year)	Labor Cost ($/Year)	Energy Cost ($/Year)
Pulp and Paper	Direct (10)	($12,467)	$3333	($15,800)	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Power Plants	Direct (14)	$28,821	$4,667	$33,488	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Metal Finishing	Direct (15)	($66,760)	$5,000	($71,760)	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Steel Mills	Direct (23)	$174,585	$15,333	$159,252	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Inorganic Chemical Plants	Direct (3)	($22,416)	$0	($22,416)	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Organic Chemical Plants	Direct (12)	$29,376	$0	$29,376	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Refinery / Oil Producer	Direct (1)	$8,065	$667	$7,398	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Miscellaneous	Direct (3)	($16,812)	$0	($16,812)	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Federal Facilities	Direct (4)	($17,803)	$1,333	($19,136)	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Rubber Fabrication	Direct (2)	$4,896	$0	$4,896	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Metal Fabrication	Direct (7)	($39,228)	$0	($39,228)	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Hospitals	Direct (0)	$0	$0	$0	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
Photographic Facilities	Direct (0)	$0	$0	$0	$0	$0
	Indirect (0)	$0	$0	$0	$0	$0
TOTALS	94 Facilities (94 Direct, 0 Indirect)	$12,615 [illegible]	**$30,333**	**($17,718)**	**$0**	**$0**

(net savings/negative costs relative to current circumstances shown in parenthesis)

0004083

Table H. Evolution of the Draft Rules and Associated Projected Total Annualized Costs, (Relative to Current Ohio Rules and Procedures)

	Proposed Rules	**Alternative Regulatory Options**
Lake Erie Basin		
Industrial Facilities	$869,000 / Year 5 Sectors Increase Cost 5 Sectors Save 3 Sectors No Change	$46,500,000 / Year 11 Sectors Increase Cost 1 Sector Saves 1 Sector No Change
POTWs	($136,000 / Year) All 3 Flow Size Categories Save	$1,210,000,000 / Year All 3 Flow Size Categories Increase Cost
Ohio River Basin		
Industrial Facilities	$12,600 / Year 4 Sectors Increase Cost 7 Sectors Save 2 Sectors No Change	$49,500,000 / Year 12 Sectors Increase Cost 1 Sectors Saves
POTWs	($295,000 / Year) All 3 Flow Size Categories Save	$11,900,000 / Year 1 Flow Size Category Increases Cost 2 Flow Size Categories Save

(net savings/negative costs relative to current circumstances shown in parenthesis)

Attachment: Mercury Treatment Strategies

Different water treatment technologies can provide different characteristic reductions in mercury levels because of the chemical or physical processes on which they are based. The level of reduction possible also depends on the initial mercury concentration in the influent stream to be treated. For influent concentrations up to 100,000 ppt, four primary treatment processes are typically effective in reducing mercury levels. The first two processes are removal by biologically activated sludge or by chemical precipitation. Both of these processes have been applied in various POTW and industrial water treatment contexts. Chemical precipitation followed by filtration can at times produce an effluent mercury concentration in the range of 100 to 1000 ppt, while achieving loading reductions on the order of 40% to 85%. Similarly, activated sludge processes can at times produce an effluent mercury concentration in the range of 10 to 50 ppt, while achieving loading reductions up to approximately 85%. Both of these proven approaches would not be effective in achieving effluent levels below 1.3 ppt or loading reductions well over 99%. The performance of both of these processes is affected by the form of mercury present in the water stream, as well as the chemical characteristics of the other co-contaminants in the stream to be treated.

The other two candidate treatment processes for mercury are ion exchange (IX), which chemically captures the mercury in the water on the surface of a specially engineered resin as the water flows across it, and reverse osmosis (RO), where the mercury is concentrated in a waste stream using pressure and concentration gradients and a system of permeable membranes. Both of these technologies have been used to "polish" or produce very high quality water in certain commercial and industrial applications.

IX is reported to achieve loading reductions greater than 85%, however, the previously described limitation on the ability to measure very low concentrations in the effluent stream creates a great deal of uncertainty regarding the limiting performance of this technology. Commercially available IX systems can be effective in reducing mercury concentrations down to about 1000 ppt with a performance guarantee from the vendor. These systems are proven and practical (due to the importance of direct contact of the water with the resin for a minimum required residence time) only for system flow rates up to about 5 to 50 gallons/minute (or 0.015 million gallons/day (MGD)), which is at the low end of the range of discharge flow rates associated with Ohio's dischargers (which is 0.01 to 50+ MGD). IX systems must typically be preceded in an overall treatment system by a more cost-effective "pre-treatment" process which reduces the majority of the contaminant mass in the stream (mercury and other co-contaminants such as organic compounds and total suspended solids) since these materials would quickly saturate or clog the IX resins and make the "polishing" operation extremely expensive and unreliable. The used up or spent resins containing the removed mercury represent a hazardous waste stream which must also be managed and disposed. Some resins can be "regenerated" or cleaned, however this process generally transfers the removed mercury into a concentrated acid or caustic solution that also requires handling and disposal as a hazardous waste. Currently, IX as a commercially available treatment option for mercury is practically and economically limited to very low flow rates (as compared to typical industrial or POTW effluent flow rates). The ability of IX systems to achieve effluent concentrations on the order of 1.3 ppt has not been demonstrated and vendors will not currently guarantee removal to levels this low. Various forms of "coated solids" also are under development as an alternative to resins. The removal performance of these materials is currently comparable to resins.

RO, the final candidate process, uses an extensive series of membrane-containing pressurized chambers to separate a slightly contaminated influent stream into a treated effluent stream of very high quality (i.e., low mercury concentration) and a second highly contaminated effluent stream of relatively lower volume or flow rate. This process is very dependent on system pressures and flow patterns and, consequently, generally involves rather large, equipment-intensive systems. RO systems can accommodate a wide range of flow rates, from very small to very large scale systems. RO treatment systems also must be preceded by a more economical pre-treatment operation to enable the reverse osmosis units to perform more economically and reliably. The dirty contaminant collection stream produced by RO can amount to approximately 5% to 20% of the flow rate of the original influent stream to be treated, depending on the system. As such, this by-product stream creates its own water management and discharge/disposal concerns. The capital costs for larger RO systems for mercury removal of the scale needed to address typical industrial or POTW discharge flows are estimated to range from $2 to $5 per gallon/day of treated flow (including the required pretreatment system). These systems are estimated to have annualized costs for typical industrial or POTW flows on the order of $10 to $100 million per pound of mercury removed. The ability of RO systems to achieve effluent concentrations on the order of 1.3 ppt also has not been demonstrated and vendors will not currently guarantee removal to levels this low.